Automatically Producing IMS AccessForAll Metadata

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ABSTRACT

Accessible e-learning is becoming a key issue in ensuring a complete inclusion of people with disabilities within the knowledge society. Many efforts have been done to include accessibility information in e-learning metadata and the major result consists in the IMS AccessForAll Metadata definition. Unfortunately the complex behavior managed by this standard could be perceived by authors as a new boring and difficult activity enforcing the idea that the production of accessible Learning Objects (LOs) is too complex to be accomplished. This paper presents a novel component of an authoring and producing software architecture, designed and implemented to automatically create the IMS AccessForAll Metadata description of an accessible LO.

Categories and Subject Descriptors

K.3.1 [**Computers ad Education**]: Computer Uses in Education, Distance learning; K.4.2 [**Computers and Society**]: Social Issues, Assistive technologies for persons with disabilities.

General Terms

Design, Experimentation, Human Factors, Standardization.

Keywords

Accessibility, Metadata, Learning Objects.

1. INTRODUCTION

A large use of multimedia components is today widely utilized to improve efficacy of Web-based instruction, ranging from Flash animations to prerecorded video-lectures [11]. These rich media are often a welcome addition to a Web-based course and are used to improve the quality and the effectiveness of learning contents in several situations, e.g. by describing a complex concept or by showing a process flow. Sometimes audio and video elements are exploited just to add a human touch to courses taught at distance [2]. Finally real lectures are frequently recorded to integrate or enrich on line materials.

In all the above mentioned situations, the provision of fully accessible and portable multimedia contents is usually considered a complex and expensive charge. Working with multimedia resources, major difficulties originate from the basic need to provide a textual equivalent for each multimedia resource and from the final accessibility evaluation that requires different tests to be accomplished. Both these tasks could become truly time-consuming, depending on the type of content that the teacher is writing and on the authoring tool he/she is using [10]. Frequently, the resulting LO is partially accessible or totally inaccessible. This could happen whether the structure of objects/alternatives is incomplete or it is related to a specific content or activity that is itself a source of barriers.

In this context, the IMS Global Learning Consortium [5], has developed several guidelines and specifications to address accessibility issues in e-learning. The IMS is a non-profit organization. Its members come from every sector of the global e-learning community and they include hardware and software vendors, educational institutions, publishers, government agencies, systems integrators, multimedia content providers, and other consortia. IMS have a fundamental role in defining specifications to ensure interoperability across e-learning systems. Main IMS guidelines and specifications on e-learning accessibility are:

- The IMS Guidelines for Developing Accessible Learning Applications [6], used to support the production of accessible learning materials.
- The IMS Accessibility for Learner Information Package (LIP) [7], to describe Personal profile of preferences (visual, aural, device) for tailored presentation of learning content (e.g. preferred /required input devices or preferred content alternatives). Profiles described by

using this specification are usually referred as ACCLIP profiles.

- The IMS AccessForAll Meta-data (ACCMD) [8] that describes accessible learning content by specifying, for example, what kind of content is being presented and if there is an equivalent or alternative form of the content.

The AccessForAll Meta-data specification is intended to make it possible to identify resources that match user's stated preferences or needs (expressed as an ACCLIP profile). ACCMD fully describe accessibility of learning content by specifying textual alternatives for each element that contains visual or auditory information. Finally, AccessForAll Metadata provides support to functional interoperability by allowing the substitution or augmentation of any resource with an equivalent one whenever it is required for accessibility purposes. To describe the alternative content structure, IMS uses a description of one primary resource, and the description of the features of zero or more additional resources that are somehow equivalents for that specific primary resource [10].

While these metadata represent a truly enabling option, implementing an ACCMD description of each LO could turn into a new tiresome and protracted task for authors.

Reducing the distance between users' needs and authors' efforts is now a crucial aspect to ensure accessibility of e-learning materials. The solution relies on authoring tools for creating LO that have to accomplish two main goals:

1. Offering support to author in creating fully inclusive materials by suggesting correct behaviors and sometimes imposing the completion of all additional information needed to ensure accessibility (e.g. once the image is inserted, the authoring tool ask for a description that is required for blind users).
2. Automatically structuring the media alternatives, both inserting correct markup inside the (X)HTML pages and describing the whole structure with ACCMD.

This paper presents the ACCMDBuilder, a component added to a preexistent authoring tool called ISA-LOB in order to obtain the ACCMD description for each created LO. In particular, the accessibility of LOs was ensured by this tool since it has been designed and implemented as described in [3]. The new component adds the automatic production of ACCMD and includes it in the SCORM [1] LO package. The latter is provided through the ISA-LOB tool that has been used in an e-learning project of the University of Bologna, (A³ Project) to create about 40 accessible LOs.

The reminder of the paper is structured as follows. Section 2 describes design issues of our system, focusing on accessibility of rich media elements. Section 3 presents the architecture of the whole system, detail on the new component that supports IMS AccessForAll Metadata. Section 4 presents a complete example of automatically created and packaged resource, with the ACCMDBuilder. Finally Section 5 concludes the paper.

2. PROVIDING ACCESSIBLE RICH MEDIA

As mentioned above multimedia contents are frequently used to enrich efficacy of e-learning materials. In particular, each module provided to students through A³ Project may include several rich media and specifically:

- Static images, animations (based on GIF and Flash objects) and simple simulations, all contained in HTML pages. GIF and Flash are just convenient formats to illustrate our approach, which anyway equally works well with other raster formats and vector ones.
- Video lectures, used by the teacher to support the learning activity and implemented by using SMIL which synchronize video, audio and a sequence of slides.

To ensure that all these multimedia elements can be offered to the user in an accessible form, different mechanisms are provided in order to force the creation of all the required equivalents (textual and not-textual) [4] [9]. In this sequel, two different scenarios for use of rich (continuous) media will be presented:

1. a Flash animation, and
2. a SMIL video lecture.

These examples concretely exemplify the two main categories of multimedia contents used in A³ without the ambition to exhaustively cover all available media and formats. In both cases, we will detail the work needed to make the content accessible, respectively in the following Section 2.1 and 2.2.

2.1 Flash Animation

Flash animations are used in A³ Project LOs to introduce concepts (mainly related to Computer Science education) that result better explained by using a graphical representation. Examples of such animations are dynamics in a streaming-based communication and client-server interaction. The chief issues to address complete accessibility are:

- Providing a similar content for people that have not or cannot use a Flash player, e.g. a sequence of images that represent the evolution of the buffer content.
- Giving a textual description of the whole animation for people that cannot see or cannot display images.

2.2 Video Lecture

From a technical point of view, in Scenario 2, we have to synchronize the three main information flows that compose the video lecture:

1. The video track, filming the instructor while teaching.
2. The audio track, playing the instructor talking.
3. The slide sequence, simply considered as a sequence of images reproducing text, schemas or other graphical elements.

We need to add two additional flows that ensure accessibility, adding the textual equivalent for people with auditory and visual impairments respectively:

4. The caption sequence; captioning is essential for deaf and hard of hearing students, for foreign students and for students with an auditory processing disability.
5. The slide contents descriptions sequence. These descriptions could be simply obtained reproducing the text contained on each slide and adding further textual descriptions of images and animations, if any.

The SMIL multimedia obtained by composing these 5 flows is compliant to Accessibility Guidelines for SMIL but is still not enough accessible, especially for students that use assistive technologies, such as screen readers or magnification systems. Two main problems arise from this rich media:

- SMIL uses strict layouts structures that are not adaptable to low resolutions needed to magnify (for students with low vision).
- The above defined presentation produces a cognitive overload to blind users. Two (synchronous) audio tracks are technically available: the main audio track reproducing the teacher talk and the audio track produced by voice synthesis by reading slide contents. Usually assistive technologies don't read textual contents that change dynamically, so the second track and its provided information are lost.

User testing phase of SMIL video-lectures has confirmed the necessity to provide alternative versions for the on line lecture.

A first alternative consists of an HTML hypertext with textual slide contents (alternative for image-based slides) linked to the corresponding audio explanation. Blind students can use this version of the video lecture by reading text of slides (with voice synthesis or Braille display) and, after or before that, listening to the teacher explaining that slide. By compounding speech synthesis and human voice the video lecture entire content is provided as auditory flow.

Another alternative version is needed to meet requirements of students who need captioning and have difficulties reading text while it is synchronously changing. Such a situation could happen, for example, to deaf or hard of hearing students who consider teacher speech too fast to be completely understood.

An automatic transcoding process transforms the original SMIL by deriving from the synchronous (SMIL) source, different discrete or semi-discrete versions of the lecture (fully accessible XHTML lectures and printable PDF documents).

3. ARCHITECTURE

Both the above mentioned rich media are normally included in A³ LOs that are created by using a set of software designed and developed to support the implementation of accessible Learning Objects. In specific, we initially have two post-production chains:

1. Flash animations are embedded in the (X)HTML pages, like the most part of hypertextual materials. In order to support this task our system provides the user with a word processor (MSWord or OpenOffice Writer) used to create formatted documents and a post-producing tool (called ISA [12]) that derives structural and semantic information. The result of this two steps activity is (i) a set of XML files containing textual contents and the SCORM metadata together with (ii) a set of media files for images, animations and other non-textual media. All alternatives described in Section 2.1 are ensured by asking each author that inserts an animation to provide also the alternative set of images and their related descriptions.
2. Video lectures are captured from real lectures and post-produced by using a different tool called MMP (MultiMedia Producer [10]). The result obtained by MMP is (i) a set of XML (SMIL or HTML) files containing the structural information together with (ii) a set of media files for images, audio, video and all the non-textual media.

In both cases an XML-based intermediate format is produced. It contains a structured representation of all the alternatives. The presence of additional information which are necessary to guarantee accessibility, is ensured by the specific tool used in each of the two cases forcing the author to specify all required data. The complete process is more exhaustively described in [3]. Once obtained all the intermediate files another post-production component creates a LO and specifically:

A. It assembles data stored in the intermediary XML files creating XHTML pages.

B. It structures all contents in appropriate directories and describes the didactical structure as a SCORM manifest by calling a component called ACCMDBuilder.

C. It creates the IMS ACCMD description of the resources.

D. It produces a single .ZIP file that represents the LO.

The Learning Object Builder (LOB) production process is based on a set of templates and configuration files that are used to define structural elements as well as layout and graphical aspects of the automatically produced LO. The whole process is depicted in Figure 1.

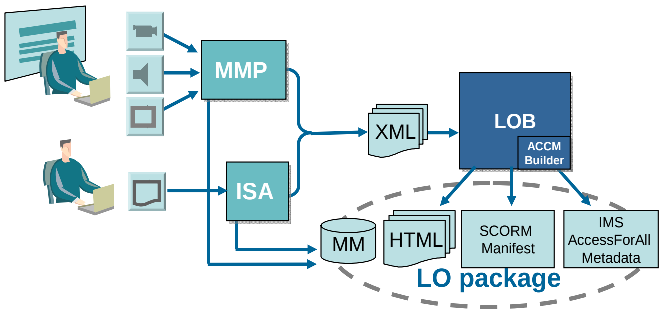

Figure 1. General Architecture

We will now focus on step C, showing the most innovative result presented in this paper.

4. PRODUCING IMS ACCMD

The ACCMDBuilder reconstructs a global XML representation of all the alternative information (The IMS manifest). An XSLT stylesheet, generates final XML metadata from data stored in the XML intermediate files. The whole amount of necessary information comes from the requirements fulfilled by authors as illustrated above. All alternative resources are identified and represented in the IMS ACCMD description. We have used the ACCMDBuilder on a benchmark resource, taken from A³ Project which contains both the cases study described in Section 2.

The following code fragments (depicted in Figure 2, 3 and 4) represent the IMS ACCMD description of the animation introduced in Section 2.1 and managed by post-production chain 1 described in section 3. The code fragment of Figure 2 describes the primary resource and the first (unique) equivalent resource of the animation: the alternative image, that is useful for people that have not or cannot use a Flash player. The primary resource (the Flash animation) is defined as a visual and textual resource.

```
…
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
<!—primay resource :animation, equivalent
alternatives: image, longdesc -->
  <resourceDescription>
    <primary hasAuditory="false"
     hasTactile="false" hasText="true"
     hasVisual="true">
      <equivalentResource>
        file://img/image024.jpg
      </equivalentResource>
    </primary>
  </resourceDescription>
</accessibility>
…
```

Figure 2. IMS ACCMD for the case study 1 (alternative image)

The `<accessibility>` is the root element that groups the accessibility information about the resource. The `<resourceDescription>` is the element that describes the features of the resource. The `<primary>` element defines the features of the primary resource. Its attributes respectively indicate:

- `hasAuditory`: Boolean value that indicates whether or not the resource contains auditory information;
- `hasVisual`: Boolean value that indicates whether or not the resource contains visual information;
- `hasText`: Boolean value that indicates whether or not the resource contains text;
- `hasTactile`: Boolean value that indicates whether or not the resource contains tactile information.

The `<equivalentResource>` element is a pointer to an equivalent resource (meta-data) of the described resource or parts of there.

```
…
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
  <resourceDescription>
    <primary hasAuditory="false"
     hasTactile="false" hasText="true"
     hasVisual="true">
      <equivalentResource>
        file://anim/sottrattivi.swf
      </equivalentResource>
    </primary>
    <equivalent supplementary="false">
      <primaryResource>
        file://longdesc/anim-sottrattivi.swf.html
      </primaryResource>
      <content>
        <!— Images as an alternative to an
         animation aren’t managed -->
      </content>
    </equivalent>
  </resourceDescription>
</accessibility>
…
```

Figure 3. IMS ACCMD for the case study 1 (alternative animation)

Figure 3 shows another code fragment of the IMS ACCMD description of the animation and its equivalent image. It is worth noticing that it is mandatory to consider and declare the primary resource as an equivalent one of itself. A textual detailed description is declared as an alternative resource for the whole animation for people that cannot see or cannot display animations. The `<equivalent>` element is the description of the features of resources that are equivalents for a particular primary resource. Its attribute `supplementary` accepts Boolean value and indicates whether or not the resource is supplementary (as opposed to alternative) to the primary resource. The `<primaryResource>` element is a reference to the primary resource (meta-data) which the described resource is equivalent to. The `<content>` defines the features of the content of the equivalent resource that parallel the ACCLIP specification.

The textual description is, it its turn, intended as an alternative for the image resource too. In particular, in the code fragment shown in Figure 4, this textual description is declared to be an alternative for visual content, in order to provide the description of the image to people that cannot see or cannot display images.

```
…
<!—Reference to the longdesc resource -->
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
  <resourceDescription>
    <equivalent supplementary="false">
      <primaryResource>
        img/image024.jpg
      </primaryResource>
      <content>
        <alternativesToVisual xmlns=
         "http://www.imsglobal.org/xsd/acclip">
          <longDescriptionLang xml:lang="ita"/>
        </alternativesToVisual>
      </content>
    </equivalent>
  </resourceDescription>
</accessibility>
…
```

Figure 4. IMS ACCMD for the case study 1 (alternative textual description)

It is worth noticing that some particular users conditions are not considered in IMS ACCMD standard. In fact, in this case it could be significant to provide alternative resources in order to meet epileptic users needs, but the standard does not consider any appropriate equivalent alternative.

The `<alternativesToVisual>` element defines visual content presented in a different modality. The `<longDescriptionLang>` element indicates that the described resource contains long description text in the specified language (through the attribute `xml:lang`) for the referenced primary resource.

Furthermore, notice that a new namespace is declared as the default one in order to define content that is alternative for visual resources. This namespace is relative to the ACCLIP profile [7]. This namespace is used whenever it is necessary to declare alternative contents to visual, auditory, textual and tactile resources.

The code fragments in Figure 5, 6 and 7 represent a more complex IMS ACCMD description, related to the video lecture introduced in Section 2.2 and then managed by post-production chain 2 (illustrated in section 3). In particular the following Figure 5 shows the description of the primary resource (the SMIL multimedia presentation) and its directly equivalents. It is worth noticing that the primary resource is declared as its equivalent resource (we’ve already detected that this is a mandatory element). The primary resource is defined as a visual, auditory and textual resource. Equivalent resources are the above illustrated HTML hypertexts. Captions (defined in Italian language) are declared as alternative for related audio synchronized streams within the SMIL multimedia presentation.

```
…
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
<!—primary resource: smil file, equivalent
image -->
  <resourceDescription>
    <primary hasAuditory="true"
     hasTactile="false" hasText="true"
     hasVisual="true">
      <equivalentResource>
        file://resources/video/video_text.html
      </equivalentResource>
      <equivalentResource>
      file://resources/video/video_caption.html
      </equivalentResource>
      <equivalentResource>
        uri:self-reference
      </equivalentResource>
    </primary>
    <equivalent supplementary="true">
      <primaryResource>
        uri:self-reference
      </primaryResource>
      <content>
        <alternativesToAuditory xmlns=
         "http://www.imsglobal.org/xsd/acclip">
          <captionType xml:lang="ita">
            <verbatim value="true"/>
            <reducedSpeed value="false"/>
            <enhancedCaption value="true"/>
          </captionType>
        </alternativesToAuditory>
      </content>
    </equivalent>
  </resourceDescription>
</accessibility>
…
```

Figure 5. IMS ACCMD for the case study 2 (SMIL multimedia presentation).

The `<alternativesToAuditory>` element defines auditory content presented in a different modality. The `<captionType>` element indicates that the described resource contains a text caption for the referenced primary resource. The `<verbatim>` element indicates that the caption is a verbatim caption. The `<reducedSpeed>` element indicates that the caption is a reduced rate level caption (or not, if its attribute `value` is set “false”). The `<enhancedCaption>` element indicates that the caption is an enhanced caption.

The fragment code shown in Figure 6 describes the first alternative HTML hypertext and its equivalent resources. This HTML page is created by composing textual slide contents (alternative for image-based slides) linked to the corresponding audio explanation.

The `<audioDescription>` element indicates that the described resource is an audio description for the referenced primary resource. Its attribute `xml:lang` defines the language of the audio description.

Besides the primary resource, the following code declares the audio description of the whole presentation to be its equivalent, in order to provide alternative for visual resources.

```
…
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
  <resourceDescription>
    <primary hasAuditory="true"
     hasTactile="false" hasText="true"
     hasVisual="false">
      <equivalentResource>
        file://resources/video/video_text.html
      </equivalentResource>
    </primary>
    <equivalent supplementary="false">
      <primaryResource>
        file://resources/video/video.smi
      </primaryResource>
      <content>
        <alternativesToVisual xmlns=
         "http://www.imsglobal.org/xsd/acclip">
          <audioDescription xml:lang="ita"
           type="standard"/>
        </alternativesToVisual>
      </content>
    </equivalent>
  </resourceDescription>
</accessibility>
…
```

Figure 6. IMS ACCMD for the case study 2 (HTML hypertext with textual description of images and audios).

```
…
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
  <resourceDescription>
    <equivalent supplementary="false">
      <primaryResource>
      file://resources/video/video_caption.html
      </primaryResource>
      <content>
        <alternativesToVisual xmlns=
         "http://www.imsglobal.org/xsd/acclip">
          <longDescriptionLang xml:lang="ita"/>
        </alternativesToVisual>
      </content>
    </equivalent>
    <equivalent supplementary="false">
      <primaryResource>
        file://resources/video/video.smi
      </primaryResource>
      <content>
        <alternativesToVisual xmlns=
         "http://www.imsglobal.org/xsd/acclip">
          <longDescriptionLang xml:lang="ita"/>
        </alternativesToVisual>
      </content>
    </equivalent>
  </resourceDescription>
</accessibility>
```

Figure 7. IMS ACCMD for the case study (HTML hypertext with textual description of images and captions)

Finally, the last fragment code (depicted in Figure 7) defines the second alternative HTML hypertext and its related equivalents. This HTML page composes textual slide contents (alternative for image-based slides) and captions (alternative for audio explanations).

In this case, the primary resource is declared to be an equivalent resource too. Furthermore the alternatives for visual resources are declared. In particular, in this version, textual descriptions are provided as slides alternative. In both these two last cases the primary SMIL multimedia presentation is intended as an equivalent resource.

It is worth noticing that IMS ACCMD standard allows the description of each single file alternative (every single image, text, audio, etc. file), but in our case we decide to consider alternative HTML hypertexts as atomic resources, in order to avoid an extreme heaviness of the IMS ACCMD code.

5. CONCLUSIONS AND FUTURE WORK

The creation of fully accessible LOs is a difficult work that needs to be backed by specific tools. In particular, these tools have a strong impact if they can improve easiness of the whole process by sustaining authoring and automatizing post-production.

This work presents components, which are embedded in an existing authoring/producing tool and automatically creates the IMS AccessForAll Metadata description of a LO, starting from the natural structure of multimedia contents. Some considerations arise from experimental uses of the tool, pointed out by the two cases study. First of all, some items can be fully described just by considering it as atomic elements. This is particularly true for continuous media whose description includes timing and synchronization elements (e.g. SMIL resources). Another aspect that impacts on the granularity of the association with ACC Meta-Data refers to the set of condition considered by this standard. As a final result we have declared that the video-lecture accessible to blind people is the one created in HTML. This is true (this version is fully accessible to blind students) but at the same time unsighted people could also appreciate the continuous version, for example for a first overview of issues introduced by the teacher. The defined structure, associated with an appropriate management of ACCLIP and ACCMD, would probably provide to blind user just the XHTLM-based materials.

Such a tool is now integrated in a complex process used inside the University of Bologna to create accessible LOs. Accessibility of e-learning materials produced has been widely tested by involving a group of people with disability in verifying on-line contents and services. Universality of materials has been tested by using different browser running on different platforms (specifically MS Internet Explorer 5.0 and later, Mozilla Firefox 1.0 and later, Netscape Communicator 7.0 and later, Lynx 2.8.4 rel. 1, IBM Home Page Reader 3.0, Apple Safari 1.0). Finally, LOs produced by our process are compliant to all the constraints considered by the Italian Law on Web Accessibility, meeting also WCAG 1.0 AA level and Section 508 requirements.

Unfortunately, the IMS description is ignored by the LCMS (Learning Content Management System) in use. Generally this new technology is not fully supported and there are just few solutions that use ACCMD and ACCLIP to provide adaptive accessible contents. We assume that a growing availability of IMS ACCMD tagged LOs will drive the development of adaptive modules for the more diffuse LCMS and will definitively diffuse the use of the whole IMS specification on accessibility. Thus, tools that support an automatic production of accessibility meta-data are a strategic issue for the complete success of such technology. The decision about granularity of the description reveals as a crucial aspect also by considering dimensional aspects. Testing the system on a set of LOs that require 32 images, 4 animations and a video-lecture we add more than 1.000 lines of ACCMD code. This is a strong reason to assert that such a meta-data have to be automatically produce by the authoring tool that creates the LO. Future work will be mainly devoted to extend the proposed approach by managing a wider set of rich media. We are also working on the harmonization of ACCMD whith requirements imposed by the Italian Accessibility Law.

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